GUIDELINE A-1

Combustion, Air Pollution Control and Monitoring Requirements for Biomedical Waste Incinerators in Ontario

Legislative Authority:

Environmental Protection Act, Part V, Section 27, and Part II, Section 9

Regulation 347, General – Waste Management

Regulation 346, General – Air Pollution

Responsible Director:

Director, Standards Development Branch
Ministry of the Environment

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Synopsis

This guideline applies to all incinerators burning biomedical waste in Ontario, including both new and existing facilities of any size.

The purpose of the guideline is to control contaminant emissions from biomedical waste incineration systems by establishing emission limits for PM (particulate matter), dioxins and furans, heavy metals, sulphur dioxide, nitrogen oxides and hydrogen chloride. The guideline was developed on the basis of best available technology and human health and environmental considerations, as well as consideration of the approaches taken by other jurisdictions. Where an incineration system co-fires biomedical waste along with any other form of waste or fuel, the more stringent requirements of this guideline or any other guideline developed with respect to the non-biomedical waste material fired in that system shall apply.

Compliance with the emission limits and consideration of the incinerator design and operating criteria described in this guideline will require the installation of air pollution control equipment, operational controls, and monitoring systems. The guideline also sets out requirements for performance testing and compliance assessment for affected facilities.

The guideline will be applied through conditions on certificates of approval for new or upgraded biomedical waste incinerators in accordance with the requirements of the *Environmental Protection Act*, Part V, Section 27, and Part II, Section 9.

The emission limits for heavy metals (cadmium, lead, mercury), dioxins, PM (particulate matter), sulphur dioxide, nitrogen oxides and hydrogen chloride in this guideline are technology-based, corresponding to the emission levels expected to be achieved using the best available control technology. In all cases, the limits are below levels which would be needed based solely on protection of human health and the environment, thus providing a significant margin of safety. The Ministry will continue to ensure protection of human health and the environment by also using the point of impingement (POI) limits set out in Regulation 346 and associated Ministry POI limits described as guideline values during the evaluation of new or upgraded biomedical waste incinerator Proposals.

Emission limits specified in this guideline will be reviewed and updated from time to time by the Ministry to reflect improvements in technology and new health and environmental information.

Earlier versions of this Guideline addressed both biomedical and municipal solid waste incineration. The requirements set out in this revision of the Guideline apply only to biomedical waste incinerators, and provide updated requirements which are more stringent than those described in earlier versions. A separate document, Guideline A-7, has been developed for application to municipal waste incinerators.

1.0 Introduction

This guideline establishes emission limits and outlines default design and operating criteria for the control of emissions to the atmosphere from biomedical waste incinerators in Ontario. It applies to all new and existing incineration facilities burning any amount of biomedical waste. Where other wastes or fuels are co-fired along with biomedical waste, the more stringent of the requirements set out in this guideline or those set out in guidelines or regulations pertaining to the other waste or fuel fired shall apply.

These limits and criteria will be used by the Ministry when assessing applications for approval of biomedical waste incinerators. This guideline supplements the requirements of Regulation 346 (RRO 1990), General – Air Pollution, including compliance with the point of impingement standards prescribed in Schedule 1 to that regulation. Biomedical waste incinerators shall also demonstrate compliance with the Ministry's other point of impingement limits set out in the most current version of the *Summary of Point of Impingement Standards, Point of Impingement Guidelines, and Ambient Air Quality Criteria (AAQCs)* published periodically by the Standards Development Branch of the Ministry.

The emission limits set out in this guideline are technology-based, meaning that they represent levels which well-designed, properly operated and generally available air pollution control technologies can achieve. These emission limits are expected to result in point of impingement concentrations which are well below the point of impingement limits set by the Ministry based on protection of human health and the environment, thus providing a significant margin of safety. In addition, control technologies designed to meet these limits for the specified pollutants are expected to limit emissions of a large number of other pollutants as a co-benefit.

Wherever practicable, the Ministry encourages source owners and operators to practice pollution prevention and waste minimization strategies which will reduce the emission levels and loadings of pollutants in the exhaust from the secondary chamber of biomedical waste incinerators prior to any installed air pollution control systems, rather than relying entirely on "bottom of the stack" controls to remove contaminants just prior to discharge. For example, when making purchasing arrangements, specifying where possible that medical supplies be mercury-free eliminates the potential for mercury to be present in at least a portion of the waste stream thereby significantly reducing mercury

emissions to all media (air, water and waste disposal). Add-on control technologies often generate solid and/or liquid waste streams which generally contain concentrated levels of the pollutants removed from the exhaust stream and require additional handling precautions to prevent the removal of air pollutants from becoming a cross-media transfer of those contaminants.

2.0 Guideline Limits

Biomedical waste incinerators shall meet the emission limits set out in Table 1 below in exhaust gases discharged to the atmosphere or at the location specified:

Table 1: Emission Limits

Parameter	Emission Limit	Comments
Particulate Matter (total)	17 mg/Rm^3	calculated as the arithmetic average of three stack tests conducted in accordance with standard methods
Cadmium	14 µg/Rm^3	calculated as the arithmetic average of three stack tests conducted in accordance with standard methods
Lead	49 µg/Rm^3	calculated as the arithmetic average of three stack tests conducted in accordance with standard methods
Mercury	20 µg/Rm^{3*}	calculated as the arithmetic average of three stack tests conducted in accordance with standard methods
Dioxins & Furans	80 pg/Rm^3 as I-TEQ¤	calculated as the arithmetic average of three stack tests conducted in accordance with standard methods
Sulphur Dioxide	21 ppmdv (56 mg/Rm^3)	calculated as the arithmetic average of three stack tests conducted in accordance with standard methods, or as the rolling geometric average of 8 hours of data from a continuous emission monitoring system

* for facilities incinerating less than 120 tonnes/year a determined effort must be undertaken to achieve 40 µg/Rm^3

¤ I-TEQ means 2,3,7,8-TCDD toxicity equivalents calculated according to the international toxicity equivalence system developed by the North Atlantic Treaty Organization's Committee on the Challenges of Modern Society (NATO/CCMS) in 1989 and adopted by Canada in 1990.

Parameter	Emission Limit	Comments
Nitrogen Oxides	172 ppmdv (324 mg/Rm^3) [expressed as equivalent nitrogen dioxide]	calculated as the arithmetic average of three stack tests conducted in accordance with standard methods, or as the rolling arithmetic average of 8 hours of data from a continuous emission monitoring system
Hydrochloric Acid (HCl)	10 ppmdv (17 mg/Rm^3) or an HCl removal efficiency of not less than 99%	calculated as the arithmetic average of three stack tests conducted in accordance with standard methods, or as the rolling arithmetic average of 8 hours of data from a continuous emission monitoring system
Carbon Monoxide	30 ppmdv (35 mg/Rm^3)	calculated as a 30 minute block arithmetic average at the outlet of the secondary chamber before dilution with any other gaseous stream, measured by a continuous emission monitoring system installed on either a permanent or temporary basis
Organic Matter	50 ppmv [expressed as equivalent methane]	calculated as a 10 minute block arithmetic average at the outlet of the secondary chamber before dilution with any other gaseous stream, measured by a continuous emission monitoring system installed on either a permanent or temporary basis
Opacity	5%	calculated as a 6 minute block arithmetic average measured by a continuous emission monitoring system

3.0 Control And Monitoring Systems

3.1 Continuous Monitoring of Emissions and Process Parameters

Appropriate control and monitoring systems to indicate and confirm good combustion and compliance with the limits of this guideline, regulations and conditions of approval shall be incorporated in any incineration proposal. Such systems shall be capable of readily signifying any aspect of substandard operation or poor combustion, so that corrective action can be taken promptly by trained operators. The results of continuous monitoring shall be periodically reviewed as part of a continuous improvement program with the aim of minimizing the incidence of poor combustion episodes and emission excursions beyond the range of normal for a facility.

3.2 Continuous Monitoring Parameters

The Ministry will expect proponents to provide a rationale for the inclusion and/or exclusion of appropriate parameters for continuous monitoring. Parameters which are to be addressed as candidates for continuous monitoring include:

- temperature(s) (e.g., at exits from primary and secondary chambers)
- total hydrocarbons
- carbon monoxide
- residual oxygen
- opacity
- carbon dioxide
- incinerator exhaust/flue gas volumetric flowrate
- hydrogen chloride
- sulphur oxides
- nitrogen oxides

A minimum monitoring package required for all facilities includes:

- primary and secondary chamber exit temperatures;
- residual oxygen content of exhaust gases at the secondary chamber exit;
- either carbon monoxide or total hydrocarbons levels in exhaust gases at the secondary chamber exit; and
- opacity in the exhaust stack (unless a wet scrubber resulting in exhaust gases saturated with water vapour is employed, in which case the opacity instrument may be waived by the Director responsible for approval of the facility).

For the remainder of the parameters listed above, the onus is on the proponent to demonstrate to the Director responsible for approval of the facility reasons why each parameter which is not proposed to be monitored should not be of concern.

In some cases, it may be reasonable to substitute continuous monitoring of process variables for specific emission parameters listed above. Where this is proposed, the proponent will be expected to establish quality assurance procedures and quality control checks to ensure that the reliability of the monitoring for the substituted parameters is equivalent to the otherwise mandated quality assurance/quality control (QA/QC) measures for the parameters which they replace.

When employed, continuous monitors shall be installed in locations which provide representative conditions to measure the relevant parameters and shall be equipped with recording devices for subsequent reference and analysis. They shall also meet minimum quality assurance and quality control requirements as set out by the Ministry; currently for emission monitors, these are generally based on Environment Canada's *Protocols and Performance Specifications for Continuous Monitoring of Gaseous Emissions from Thermal Power Generation* (Report EPS 1/PG/7, September 1993).

4.0 Compliance Assurance

4.1 Emission Compliance Testing

Within three months of start-up, all incinerator units shall determine compliance with the limits set out in Table 1 through source emissions testing performed in accordance with the methods and procedures documented in the Ontario Source Testing Code (Procedure A-1-1), under maximum operating feed rates for the combustor. Thereafter, performance tests shall be repeated at a minimum frequency of once per year, with the anniversary date corresponding to the day and month of the beginning of the first compliance test.

Source emissions testing for dioxins and furans shall be conducted to determine emissions of all of the contaminants for which Toxic Equivalency Factors (TEFs) have been established by the North Atlantic Treaty Organization's Committee on the Challenges of Modern Society (NATO/CCMS), and results expressed as I-TEQ using the NATO/CCMS TEFs. Compliance will be determined based on measured I-TEQ emission levels. Table 2 provides a listing of the contaminants used, and the TEFs assigned under the NATO/CCMS scheme.

In determining I-TEQ emission levels, where the analytical results indicate that the amount of a particular isomer of dioxins and furans, referenced in Table 2, is less than the detection limit reported by the laboratory analyzing the source emission testing samples the amount of dioxins and furans to be reported as the toxic equivalent concentration (in I-TEQ) shall be determined by using the reported detection limit as the amount present for that isomer. The reported detection limits shall be determined by the laboratory at the time the source emission testing samples are analyzed based on analysis of appropriate replicate low level samples or blanks, and not on the basis of a standard "method detection limit."

Table 2: Table 2: NATO/CCMS 1989 Toxic Equivalency Factors (TEFs)

Isomer	TEF Value
PCDDs (Dioxins)	
2.3.7.8-TCDD	**1**
1.2.3.7.8-PeCDD	**0.5**
1.2.3.4.7.8-HxCDD	**0.1**
1.2.3.7.8.9-HxCDD	**0.1**
1.2.3.6.7.8-HxCDD	**0.1**
1.2.3.4.6.7.8-HpCDD	**0.1**
1.2.3.4.6.7.8.9-OCDD	**0.001**
PCDFs (Furans)	
2.3.7.8-TCDF	**0.1**
1.2.3.7.8-PeCDF	**0.05**

Isomer	TEF Value
2.3.4.7.8-PeCDF	**0.5**
1.2.3.4.7.8-HxCDF	**0.1**
1.2.3.7.8.9-HxCDF	**0.1**
1.2.3.6.7.8-HxCDF	**0.1**
2.3.4.6.7.8-HxCDF	**0.1**
1.2.3.4.6.7.8-HpCDF	**0.01**
1.2.3.4.7.8.9-HpCDF	**0.01**
1.2.3.4.6.7.8.9-OCDF	**0.001**

Where emissions problems occur with an operating combustor, the Director may require additional source emissions testing to be conducted by the operator.

In cases where the Ministry concludes that a proposed combustion system design may not be capable of consistently maintaining good combustion (see Section 7), as a condition of approval, the Ministry may require performance testing for additional emission parameters that are by-products of incomplete combustion, such as carbon monoxide; polycyclic aromatic hydrocarbons (PAHs) such as benzo(a)pyrene, biphenyl, and naphthalene; chlorinated aromatic compounds such as polychlorinated biphenyls (PCBs), chlorobenzenes and chlorophenols; volatile organic compounds (VOCs) such as formaldehyde; and odour.

If the annual source emissions testing indicates that the concentration of dioxins and furans has remained consistently below 32 pg/Rm^3 as I-TEQ for five (5) consecutive years, then the source operator/owner may exclude dioxins and furans from the annual source emissions testing every second year as long as the concentration of dioxins and furans continues to remain below 32 pg/Rm^3 as I-TEQ.

Source testing will be conducted in accordance with a pre-test plan developed in accordance with Ontario Source Testing Code, augmented by any requirements expressed by the Manager, Technology Standards Section, Standards Development Branch, Ministry of the Environment, or successor, on source testing issues which are not directly addressed in that Code.

4.2 Facility Auditing

At a frequency of at least once a year (or more often as determined by the Director responsible for approval of the facility), the operator shall contract a qualified third party to carry out an audit of the facility and its operation. The audit should include:

- a review of the quality and quantity of waste received and incinerated;
- a review of pollution prevention measures taken to reduce emissions of pollutants from the facility;
- a review and assessment of operating records including recording charts of continuous emission monitors;

- a review of scheduled and actual maintenance;
- a physical inspection of the condition of the incinerator and the associated pollution control equipment;
- a review of ash quality, handling and disposal practices;
- review of any complaints and/or incidences of unacceptable emissions and the reasons therefor; and
- any other information that the auditor considers relevant to an assessment of the facility's ability to operate within the limits set out in the certificates of approval.

A written report on the audit shall be submitted to the Ministry and shall be made available to the general public on request.

5.0 Reporting

5.1 Emission Limits Compliance Testing

A report on the emissions testing performed in accordance with the requirements under sub-section 4.1, shall be forwarded to the ministry's local district office within 90 days of completion of the testing. The report shall contain all of the test data and information as required by the Ontario Source Testing Code, and shall include, but not be limited to:

1. an executive summary;

2. dates when source emissions testing was carried out;

3. process description, records of waste composition and feed rate during the source measurement;

4. records of operating conditions, including but not limited to:

    (1) records of all continuous emission monitoring systems, including temperature and pressure sensors, for the period when the source emission testing was taking place;

    (2) liquid and/or reagent and gas flow rates for all components of the air pollution control system;

    (3) any other records that may affect the evaluation of the source emissions testing report;

5. procedures followed during the source emissions testing and any deviation from the pre- test plan and the reasons therefore;

6. the results of the analyses of the stack emissions;

7. a summary table that compares the source emissions testing results, the monitoring data and the records of operating conditions during the source emissions testing to the requirements imposed by the Environmental Protection Act, Regulation 346 and this Guideline

This report shall also be made available to the public on request. In addition, the incinerator operator should provide a plain-English summary report of the results of the performance tests for general public distribution.

5.2 Unscheduled Shutdown

In the event of an unscheduled shutdown of the air pollution control system serving a biomedical waste incinerator, the incinerator is to be immediately shut down in a controlled fashion. Where such an occurrence results in uncontrolled or inadequately controlled emissions to the environment (e.g., through a bypass stack or due to lack of function in the air pollution control system), the Ministry's Spills Action Centre is to be informed by telephone immediately. In any event, the incinerator operator shall, within 3 months of the occurrence, submit a written report to the Ministry's local district office setting out the reasons for the shutdown and the measures that have been taken to prevent a recurrence.

6.0 Design And Operation Considerations For Biomedical Waste Incinerators

The objective of this section is to provide guidance on the design and operation consistent with achieving good combustion conditions in biomedical waste incinerators and proper disposal of the ash residue. Minimum design and operating parameters for incinerator temperature, residence time and combustion air distribution are recommended to provide guidance to proponents in designing incineration systems that will achieve high combustion efficiencies. However, it should be emphasized that these requirements are not intended to restrict design technology. The Ministry will consider alternative incineration systems for approval provided that they are designed and operated to achieve a high level of combustion efficiency. Achievement of high combustion efficiency will be assessed based on ability of the alternative system to meet or exceed the Guideline Limits for particulate matter, dioxins and furans, nitrogen oxides, carbon monoxide, organic matter, and opacity in a statistically significant number of test runs. Proponents of such alternative systems will be expected to provide thorough documentation, including test data generated by reputable third-party testing agencies and verified using rigorous verification procedures such as those employed in Canada's Environmental Technology Verification Program to establish that this is the case.

The Ministry will evaluate the design and operating parameters of incinerators when reviewing an application for approval, and the parameters described subsequently will be viewed as the minimum requirements for approval except where an applicant makes a sound technical case for alternative criteria as discussed in Section 7.0. Detailed engineering drawings, specifications and calculations to support the design and operating parameters are required for the evaluation.

6.1 Incineration Temperature

The minimum combustion temperature achieved in a biomedical waste incinerator is critical to achieving high-efficiency combustion and destruction of organic materials.

The Ministry acknowledges that incineration temperatures in the combustion zone (see definition) of biomedical waste incinerators will vary with the design. These temperatures are normally specified in an incinerator design and are generally in the range of 1000°C or higher in order to ensure high-efficiency combustion and destruction. Incinerators should be capable of sustaining, on a continuous basis, an incineration temperature about 100 Celsius degrees greater than the design operating temperature.

An auxiliary burner should be incorporated into the design to ensure that the minimum operation temperature is maintained:

- at start-up before the commencement of the incineration cycle;
- during shutdown until all combustion of waste has ceased; and
- when necessary during other phases of operation.

Note that proponents of any design proposing to use a design operating temperature of less than 1000 °C will be expected to provide thorough documentation and verified test data to establish that they will achieve a high level of combustion efficiency as described in Section 6.0 above.

6.2 Combustion Gas Residence Time

The Ministry recognizes that there are biomedical waste incinerators in operation throughout North America with a wide range of combustion gas residence times. A residence time of **two seconds** in the combustion zone at the minimum combustion temperature specified in the design is generally considered representative of state of the art combustion technology and is considered appropriate for new units. For existing units seeking approval to continue operation, a minimum residence time of **one second** in the combustion zone at the minimum combustion temperature specified in the design may be considered adequate to provide an acceptable level of combustion efficiency.

The residence time should be calculated from the secondary burner(s) flame front. If air is introduced downstream of the burner flame front, residence time should be calculated from the final air injection point.

Again, note that proponents of any design proposing to use a residence time of less than two seconds for new units, or one second for existing units seeking approval to continue operation, will be expected to provide thorough documentation and verified test data to establish that they will achieve a high level of combustion efficiency as described in Section 6.0 above.

6.3 Combustion Air Distribution

Combustion air systems should be designed to control air distribution within the incinerator and the Ministry recognizes that these systems vary widely. Ideally, control systems should have the capability of adjusting the distribution of combustion air in order to provide the desired level of residual oxygen in the exhaust gases under all incinerator loading conditions.

6.4 Oxygen Availability

The lack of sufficient oxygen in the flue gases leaving the incinerator is an indicator of incomplete combustion and is a contributing factor to the discharge of volatile organic compounds. Incinerators should be designed and operated to ensure that sufficient residual oxygen in the flue gas exhaust has been provided to minimize the discharge of products of incomplete combustion during the entire incineration cycle.

Incinerators and their air distribution systems will normally be designed and operated to provide an oxygen rich atmosphere with a minimum oxygen content of 6% O_2 (by volume, actual basis) in the undiluted exhaust gases leaving the combustion zone, determined as a 10 minute block average.

Once again, note that proponents of any design proposing to use an operating oxygen residual of less than 6 % will be expected to provide thorough documentation and verified test data to establish that they will achieve a high level of combustion efficiency as described in Section 6.0 above.

6.5 Gas-Phase Turbulence and Mixing

The design of an incinerator should provide and the operation maintain a high degree of gas-phase turbulence and mixing in the combustion zone. This can usually be achieved through appropriately located/directed air jets, changes of flue gas flow direction, baffling, and constriction of cross-sectional flue gas flow area.

6.6 Range of Operation

Biomedical waste incinerators should be designed to achieve the temperature, residence time, oxygen availability and turbulence conditions specified in their design over the entire expected range of values of the incinerator operating parameters, including:

- feed rate (including minimum and maximum rates);

- ultimate analysis, heating value, ash and moisture content of the waste;
- combustion air; and
- heat losses.

6.7 Continuous Operation of Air Pollution Control Systems

Air pollution control systems for incinerators shall be designed to operate on a continuous basis, as much as possible, whenever there is waste burning in the incinerator. The design of the system shall incorporate consideration of:

- the conditions which could lead to an unscheduled shutdown of the air pollution control system;
- means of ameliorating such conditions; and
- air pollution control bypassing which cannot be avoided.

The incinerator system controls shall be designed to ensure the shutdown of the incinerator immediately upon an unscheduled shutdown of the air pollution control system in a manner that will minimize air emissions. The control system shall also be designed to record pertinent information for subsequent reporting to the ministry's local district office and for an assessment of the reasons for the shutdown and potential measures to prevent a recurrence.

6.8 Combustion Controls

Automatic measures should be built into the control strategy for incinerators which will, upon crossing the set point for minimum temperature or residual oxygen content, cause auxiliary burners to ignite or air supply to be increased, as necessary. Capability should be provided in the form of supplying such additional burner and air supply capacity in such a way that it can be activated by an automatic control system to meet these needs (e.g., supply of separate "auxiliary" burner(s) or air supply fans(s), or fully modulating burners/fans with excess capacity beyond design requirements for typical operation) . The automatic combustion control system should be sufficiently sophisticated (e.g., microprocessor controlled) that it can ensure good combustion for variations over the full range of operation for the incinerator as well as reasonably expected excursions beyond the normal range of operation.

6.9 Ash Management

Fly ash from the incinerator's energy recovery and/or pollution control system shall be handled separately from the burning zone's bottom ash. Fly ash must be tested for leachate toxicity if the operator wishes the Director(s) responsible for issuing the Certificate(s) of Approval for the facility to consider that material as non-hazardous. The ministry's test method for leachate toxicity is contained in Regulation 347 (i.e., the Toxicity Characteristic Leaching Procedure or TCLP); the sampling procedure and results evaluation procedure is to follow the same techniques as those described for non-hazardous solid waste incinerators in the ministry's policy publication, *Protocol for Sampling and Evaluating Fly Ash from Non-Hazardous Solid Waste Incineration*

Facilities. Sampling and evaluation of fly ash samples during routine facility operation are to be done at a frequency and subject to such detailed considerations as may be determined by the Director(s) responsible for issuing the Certificate(s) of Approval for the facility.

Incinerator operators shall analyse both bottom and fly ashes sent to disposal for Toxicity Characteristic Leaching Procedure results, and ultimate analysis during performance tests or at the direction of the Director(s) responsible for issuing the Certificate(s) of Approval for the facility.

The incinerator operation shall be controlled such that the organic content of the bottom ash shall be minimized to the greatest degree possible. A maximum organic content of 10 % (by weight) is generally considered achievable for biomedical waste incinerators. The organic content of ash sent for disposal shall be periodically determined through sampling and analysis at a frequency of at least four times per year.

6.10 Pressure Control and Emergency Exhaust

Incinerators should be designed to operate under negative pressure during all phases of operation. If an emergency exhaust is provided in the design, its location and method of operation should be specified.

7.0 Approval Of Incinerator Design And Operating Criteria

Part 9 of the *Environmental Protection Act*, requires that a proponent of a biomedical waste incinerator apply to the Ministry of Environment for approval to install and operate an incinerator. If the application is approved, the ministry will issue a certificate of approval for the incinerator which will incorporate emission limits, and monitoring and operating requirements, based on the limits and criteria set out in this guideline. The certificate may also incorporate other requirements specific to the location and the nature of the application for approval.

> *The design and operating criteria discussed in this guideline are provided as a guide to achieving good combustion. Other design and operating criteria may be proposed for approval but the proponent will be required to show that the alternative criteria have been successfully used elsewhere in the design and operation of a biomedical waste incinerator, and have achieved high combustion over the range of feed rate conditions that will be encountered. Achievement of high combustion efficiency will be assessed based on ability of the alternative system to meet or exceed the Guideline Limits for particulate matter, dioxins and furans, nitrogen*

oxides, carbon monoxide, organic matter, and opacity in a statistically significant number of test runs.

Information submitted in support of claims for other operating parameter criteria (particularly the minimum operating temperature, combustion gas residence time and oxygen availability criteria) must be supported by adequate information generated by reputable third-party testing agencies with demonstrated competence using the test procedures involved and must withstand scrutiny using rigorous verification procedures such as those used by Canada's Environmental Technology Verification Program.

The ministry will evaluate the design and operating parameters of incinerators when reviewing an application for approval. Detailed engineering drawings, specifications and calculations to support the design and operating parameters are required for the evaluation.

8.0 Definitions

Burner Flame Front:

The visible luminous front zone of the flame, formed by the burner, in which intense localized gas phase combustion occurs.

Combustion Air:

The air supplied to the incinerator for the burning of the waste and/or the fuel.

Combustion Zone:

The combustion volume between the flame front and the point where the combustion gas temperature falls below the specified combustion temperature.

Feed Rate:

The weight of waste introduced or fed into the incinerator per unit time.

Gas-Phase Turbulence:

Turbulence in the combustion gases, denoting an irregular fluctuation (i.e. mixing and eddying) superimposed on the main stream. Good mixing of the products of incomplete combustion (primarily carbon monoxide and hydrocarbons) and of the combustion air is promoted by a highly turbulent flow of the gases.

Negative Pressure:

A pressure that is less than ambient pressure.

Operating Parameters:

The variables of the incinerator process and waste stream used to control the operation of the incinerator. These include: the waste feed rate, composition, and heating value; combustion air feed rate(s); and heat losses and production.

Reference flue gas conditions (R):

- Temperature 25°C
- Pressure 101.3 kPa
- Oxygen content 11%
- Water content nil (dry conditions)

Reference flue gas conditions are denoted by the capital "R" in mg/Rm^3 (milligrams per reference cubic metre), for instance.

9.0 Abbreviations

HCl	hydrogen chloride or hydrochloric acid
I-TEQ	international toxic equivalents (to 2,3,7,8 tetrachloro dibenzo-*p*-dioxin) as determined using the toxicity equivalence factors developed by the North Atlantic Treaty Organization's Committee on the Challenges of Modern Society (NATO/CCMS) in 1989, and adopted by Canada in 1990
kPa	kilopascals
mg/Rm^3	milligrams per reference cubic metre
NO_x	nitrogen oxides
O_2	oxygen
pg/Rm^3	picograms per reference cubic metre
ppmdv	parts per million, dry basis, by volume
ppmv	parts per million by volume (no moisture content correction)
R	reference conditions
SO_2	sulphur dioxide
$\mu g/Rm^3$	micrograms per reference cubic metre